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COMPLETE SPECIFICATION

Improvements in and relating to Centrifugal Separators

We, BAKER PERKINS LIMITED, of Westwood Works, Peterborough, in the County of Northampton, a Company registered under the laws of Great Britain, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates broadly to new and useful improvements in centrifugal separators of the type used primarily for separating the mother liquor or syrup from sugar crystals.

In the manufacture of sugar, mother liquor is centrifuged from the crystals, and the latter are then washed with water to remove any liquor adhering thereto. Usually the crystals are permitted to accumulate to a considerable depth in the centrifuge basket and are removed from time to time by suitable mechanical strippers.

A curb ring is provided at the rim of the basket to prevent the crystals from spilling during the centrifuging operation. This curb ring must meet certain rigid specifications and no entirely satisfactory way of mounting it on the basket has heretofore been devised. For example, the curb ring must rotate with the basket to prevent undesirable heat from being developed due to friction between the parts. Further, the curb ring must seal the rim of the basket during the centrifuging operation but be readily removable so that the crystals can be easily stripped from the basket. The curb ring cannot be fastened directly to the centrifuge basket, since it then interferes with the operation of the mechanical strippers. The usual practice is to mount the ring on the stripper so that it moves with the latter. However, the stripper is disposed in the basket and the posts which support the curb ring prevent the crystals from building up uniformly on the basket. As a result, the sugar crystals do not deposit uniformly on the wall of the basket, the weight of the basket is not balanced and a gyratory effect results during the centrifuging operation. Further, the supporting posts intercept the streams of syrup and wash water charged to the basket and cause much splashing and unnecessary spillage.

Also, it has been necessary heretofore to stop or at least greatly reduce the rotary speed of the centrifugal basket when the crystals are stripped therefrom. This results in a relatively high power consumption, as considerable starting torque is required to bring the machine to full speed after each unloading operation. Moreover, considerable time is lost during the slowing-down and starting-up operations.

An important object of the present invention is to provide a centrifugal separator of the above-mentioned character wherein the curb ring is supported in a novel manner by means outside the basket.

Another object of the invention is to provide a centrifugal separator of the above-mentioned character wherein the curb ring and its adjuncts are unobstructively arranged so as not to interfere with the syrup or wash water or the build up of sugar crystals in the basket.

Still another object of the invention is to provide a centrifugal separator of the above-mentioned character with stripping of the sugar crystals from the basket.

Yet another object of the invention is to provide a centrifugal separator of the above-mentioned character wherein the curb ring is uniquely shaped and associated with the basket to prevent the syrup in the basket from leaking over the top of the basket and mixing with the sugar crystals which have been removed from the basket.

A further object of the invention is to

[Price 2/-]

provide a centrifugal separator of the above-mentioned character in which the basket rotates continuously at a constant high speed, thus eliminating starting torque required to bring the machine to full speed after each unloading operation and saving the time normally lost during stoppage of the machine.

A still further object of the invention is to provide a centrifugal separator of the above-mentioned character having novel means for maintaining the mother liquor and wash water separate from each other.

A yet further object of the invention is to provide a centrifugal separator of the above-mentioned character which is more efficient in operation and is capable of handling a greater volume of syrup than has heretofore been possible.

Other objects and advantages of the invention will be apparent during the course of the following description.

The invention consists in a centrifuging apparatus comprising a rotatable and reciprocable basket having a foraminous annular side wall; means for charging said basket with material to be filtered; an axially fixed stripper member snugly fitting within and rotatable with said basket; and actuator means for reciprocating said basket on said stripper.

In the drawings forming a part of this specification and wherein like numerals are employed to designate like parts throughout the same:

Figure 1 is a vertical sectional view through a centrifugal separator embodying the invention and showing the centrifugal basket in its normal, raised position;

Figure 2 is a view similar to Figure 1 but showing the centrifugal basket lowered to discharge the sugar crystals;

Figure 3 is an enlarged, fragmentary view of the portion of Figure 2 enclosed in the circle 3;

Figure 4 is an enlarged, fragmentary, transverse sectional view taken on the line 4—4 of Figure 1, and particularly illustrating the construction of the centrifugal basket;

Figure 5 is an enlarged, fragmentary view of the portion of Figure 1 enclosed in the circle 5;

Figure 6 is an enlarged, fragmentary view of the portion of Figure 1 enclosed in the circle 6 but showing the curb ring raised slightly from the centrifugal basket;

Figure 7 is a vertical sectional view taken on the line 7—7 of Figure 1, particularly illustrating the spraying device for washing out the centrifugal basket underneath the stripper;

Figure 8 is an enlarged, fragmentary view of the portion of Figure 1 enclosed in the circle 8;

Figure 9 is an enlarged fragmentary, vertical sectional view showing a modified means for raising and lowering the curb ring; and

Figure 10 is a diagrammatic view showing the electrical network, hydraulic fluid lines, and water piping which control, operate, and supply the centrifugal separator.

Considered in certain of its broader aspects, the present invention comprises a centrifuge basket 20 mounted in a suitable open framework 22 and rotatably driven by a motor 24 through a vertical tubular shaft 26. Also mounted on the shaft 26 for rotation therewith and fitting snugly within the basket 20 is a disc-shaped stripper 28. The stripper 28 is axially as well as rotatably fixed on the shaft 26, and the basket 20 is moved up and down on the shaft relative to the stripper by a fluid motor 30. Normally the basket 20 is raised as shown in Figure 1, so that the stripper 28 is disposed at the bottom thereof; however, when sugar crystals accumulate to a desired depth in the basket, it is lowered to the position shown in Figure 2. As the basket 20 moves downwardly, the crystals are supported by the stripper plate 28 and spill over the top of the basket into an outer annular surrounding chamber 31. From the chamber 31, the crystals are expelled by means hereinafter described in detail into a discharge spout 32.

A slurry of syrup and sugar crystals is charged to the basket 20 through a pipe 34 controlled by a charging valve 35 (Figure 10) and the contents are prevented from spilling over the top of the basket by a curb ring 36. Valve 35 conveniently may be a valve of the type shown in our copending application No. 19732/48 (Serial No. 653,125). The charging operation may be accomplished while the basket 20 is rotating at a relatively high speed and the liquor or syrup is thrown outwardly by centrifugal force through the foraminous vertical wall of the basket into an inner annular surrounding chamber 38. The curb ring 36 is supported by the stripper 28 through rods 40 and 42 and a connecting ring 44. The stripper 28 drives the curb ring 36 at the same rotative speed as the basket 28 and holds it axially fixed at all times. When the basket 20 is fully raised, the open top thereof is pressed solidly against the under surface of curb ring 36 which seals the basket at the rim and prevents the contents of the basket from spilling. However, when the basket 20 is lowered, it drops away from the curb ring 36 so that

the sugar crystals can be stripped or discharged over the top of the basket in the manner hereinabove described.

After the sugar crystals have accumulated to the desired depth in basket 20, flow through the supply pipe 34 is shut off by means hereinafter described in detail and the crystals in the basket are subjected to a water rinse. Water is introduced into the basket through a pipe 46 which extends downwardly between the drive shaft 26 and the curb ring 36. The rinse water thrown outwardly from the basket 20 into the chamber 38 by centrifugal force in the same manner as the mother liquor. This water washes away any syrup still adhering to the crystals in the basket 20, and also cleans the basket and the walls of the surrounding chamber 38.

Both the mother liquor and the rinse water are discharged from the chamber 38 through a port 48. However, the mother liquor is subjected to further processing, and it is therefore desirable that it be collected separately from the rinse water. In order to accomplish this result, concentric annular housings 50 and 51 are mounted around the lower portion of chamber 38 which housings have chambers 52 and 54 provided with inner annular inlets 56 and 58. The outer housing 50 is fixed and the inlet is positioned to register with the port 48. The inner housing 51, on the other hand, is vertically movable by means hereinafter described in detail. Normally, housing 51 is lowered with the inlet 58 out of register with port 48, but it can be raised to close inlet 56 and to move the inlet 58 into register with the port. Thus, by raising or lowering the housing 51, either one or the other of the inlets can be brought into register with the discharging port 48. In practice, the housing 52 is lowered, as shown in Figure 1, during the charging operation, so that the mother liquor is collected in the outer chamber 52 and raised during the rinsing operation to the position shown in Figure 8, so that the rinse water is collected in the inner chamber 54. The mother liquor is discharged from chamber 52 through an outlet 60 for further processing and the rinse water is discharged from chamber 54 through an outlet 62 to any suitable place of disposal.

From time to time during operation of the separator it is necessary to wash between the bottom of the basket 20 and the stripper 28 to remove syrup and occasional sugar crystals which by-pass the stripper. To this end, a wash pipe 64 is arranged vertically below the basket 20 with the discharge end thereof facing upwardly toward the bottom of the basket. The stream of water from pipe 64 is collected in a downwardly opening, annular groove 66 provided in the bottom of the basket 20 and passes upwardly into the basket through a series of passages 68. In this connection, it will be observed that the annular groove 66 is formed with an upwardly and outwardly inclined outer wall 70 and that the passages 68 extend upwardly from this wall. As a result of this arrangement, substantially all the water discharged by pipe 64 passes into the basket 20, and very little water is lost as overflow or spillage.

The pipe 64 is carried by a fluid motor 72 which moves it vertically relative to the basket 20. This is necessary, since the outlet of pipe 64 should be disposed in close proximity to the bottom of the basket 20 during the washing operation; however, during normal operation of the separator, the pipe 64 must be positioned a considerable distance below the basket in order not to interfere with vertical movement of the latter.

Certain details of construction not readily apparent from the above general description are now given.

The basket 20 has a generally disc-shaped bottom 74 and a foraminous circular side wall 76. The latter is provided with a lining which filters the sugar crystals and permits the basket to slide easily on the stripper 28.

As perhaps best shown in Figure 4, the lining comprises a plurality of similar vertically spaced wire rings 78 which fit snugly within the vertical wall 76 and fitted over each ring is a band 80 of sheet metal or the like. As shown in Figure 5, each band 80 is essentially V-shaped in transverse section and is arranged with the flange portions thereof in embracing relation to its respective ring 78. Also, it will be observed that the bands 80 project substantially beyond the wires 78, and the projecting portions thereof are notched to receive the vertical bars 82. Bars 82 are uniformly spaced and the spacing is such that the sugar crystals are retained but the liquor and rinse water pass readily therebetween. Also, the inner vertical surfaces 84 of the bars 82 are flat and smooth to slidably engage the stripper 28. In this connection, it will be observed that the bars 82 project substantially beyond the carrier bands 80 so that the periphery of the stripper 28 engages only the vertical surfaces 84 and is not required to pass over any intersecting transverse members during vertical travel of the basket 20. Also, the smooth surface presented by the vertical strips 82 facilitates removal of the sugar crystals

from the basket.

The vertical drive shaft 26 extends axially through the basket 20, and the bottom 74 of the basket is formed with a centrally located upstanding boss 86 through which the shaft passes. A stuffing box 88 on the boss 86 and surrounding the shaft 26 provides a fluid tight seal between the basket and the drive shaft. Drive shaft 26 preferably is coupled to the motor 24 by a universal joint 90 and is journaled for rotation in upper and lower bearings 92 and 84. The upper bearing 92 conveniently can be attached to an overhead portion of the framework 22. An unbalanced load in the basket 20 occasionally causes a gyratory effect; and, according to the present invention, this phenomenon is compensated by mounting the lower bearing 94 for free floating movement in a guide 96 which in turn is fastened to bottom members of the frame 22. As a result of this construction, the lower bearing 94 is permitted to gyrate freely within limits defined by the guide 96.

As suggested, the basket 20 rotates with the shaft 26 and is movable vertically on the shaft by the fluid motor 30. Specifically, the cylinder 98 of the motor 30 is arranged concentrically around the drive shaft 26 below the basket 20, and the upper end thereof abuts against and is welded or otherwise fixed to the bottom 74. Thus, the bottom 74 closes and the stuffing box 88 seals the upper end of the cylinder 98. A piston 100 is keyed, as at 102, to the cylinder 98 and, as at 104 to the drive shaft 26. The key 104 connects the piston 100 to the drive shaft 26, and the key 102 connects the piston to the cylinder 98; however, the key 104 axially fixes the piston on the crankshaft, whereas the key 102 is freely slidable in a guideway 206 which extends the full length of the cylinder 98. Thus, the drive shaft 26 rotatably drives the basket 20 through the piston 100, and cylinders 98 and hydraulic pressure admitted to one side or the other of the piston will raise or lower the cylinder 98 and basket 20 as a unit on shaft 26.

According to the present invention, hydraulic fluid is supplied to the motor 30 through the shaft 26 to raise and lower the centrifugal basket 20. More specifically a pipe 108 is mounted concentrically in the tubular shaft 26, which pipe extends from the upper bearing 92 to a point below the piston 100 and is sealed at its ends to the shaft 26. Hydraulic fluid is admitted into the shaft 26 above the pipe 108 through an inlet 112, and this fluid is conducted downwardly through the pipe 108 to discharge ports 114 which open into the cylinder 98 below the piston 100. Also, hydraulic fluid may be introduced into the annular space 116 between the shaft 26 and pipe 108 through an inlet 118, and such fluid is conducted downwardly in the annular space to discharge ports 120 which open into the cylinder 98 above the piston 100. The hydraulic fluid may be directed either to inlet 112 or inlet 118 by a suitable solenoid actuated control valve designated generally by the numeral 122. Manifestly, if valve 122 is operated to direct fluid to inlet 112, fluid pressure in the cylinder 98 below piston 100 will move the cylinder and basket 20 downwardly on the shaft 26. On the other hand, if valve 122 is operated to direct hydraulic fluid to inlet 118, fluid pressure in the cylinder 98 above piston 100 will move the cylinder and basket 20 upwardly on shaft 26. Thus, by proper operation of the control valve 122, the basket may be raised or lowered periodically without interrupting or checking the rotative speed of the basket.

The stripper plate 28 also is formed with a central boss 124 through which the shaft 26 passes and which is fixed to the shaft by a key 126. An annular shoulder 128 formed on shaft 26 below the stripper 28 and a collar 130 fixed on the shaft above the stripper by member 131 co-operates to hold the latter axially fixed on the shaft. Thus, stripper plate 28 rotates in unison with the basket 20. However, when the basket 20 is lowered, crystals supported by the stripper 28 spill over the top of the basket into chamber 31.

The particular shape of the curb ring 36 and the manner in which it is associated with the basket 20 comprise an important feature of the invention. As perhaps best shown in Figure 5, the inner annular portion 132 which projects radially inwardly across the basket 20 is downwardly offset to define a radially outwardly facing annular surface 134 which snugly fits an inturned flange 136 on the rim of the basket 20. Further, it will be observed that the surface 134 extends downwardly below the flange 136 to define an annular pocket 138, and this pocket communicates with an annular series of holes 140 which are provided in the side wall of the basket immediately below the flange 136. By reason of this unique construction, the mother liquor or syrup is prevented from leaking between the curb ring 36 and the rim of the basket 20. Any syrup which tends to crawl up the side wall of the basket is checked by the inturned flange 136 and tends to accumulate in the pocket 138.

Instead of working through the relatively tight joint between the basket 20, and the curb ring 36, the syrup follows the path of least resistance and flows outwardly through the holes 140. In this connection, it will be observed that the holes 140 discharge into the surrounding inner chamber 38 and are disposed of in the manner hereinabove described. Also, it will be observed that the holes 140 are relatively large in diameter so that the drainage area at the joint between the curb ring and the basket is much greater in comparison to the volume to be drained than at any other point. This feature is of particular importance since any syrup passing over the rim of the basket 20 contaminates the sugar crystals and causes sticky lumps in the finished product.

As suggested, the manner in which the curb ring 36 is supported outside the basket 20 is another important feature of the invention. By reason of this construction, the supports are unobstructively positioned, and at the same time the curb ring is properly supported to rotate in unison with the basket 20 and stripper 28. Also, the curb ring effectively seals the top of the basket and prevents leakage of syrup therefrom during the centrifuging operation. However, by reason of the unique manner in which the basket 20 and curb ring 36 are combined and correlated, the basket drops away from the curb ring during the discharging operation so that the crystals are readily expelled over the top of the basket.

The chamber 38 which is disposed immediately around the basket 20 is formed by concentric walls 142 and 144. The inner wall 144 depends from the basket 20 and the upper edge thereof is formed with a horizontal flange 146 which overlies and is spot welded or otherwise fastened to an outwardly extending flange 148 on the basket. At its lower edge, the wall 144 is formed with an outwardly extending flange 150 which supports an inwardly extending flange 152 on the outer wall 142. The wall 142 extends to the top of the basket 20 and has an inwardly extending flange 154 which fits snugly around the rim of the basket 20 and closes the top of chamber 38 against the entrance of sugar crystals from the basket. In this connection it will be observed that the inner wall 144 and lower portion of the outer wall 142 provide an annular sump at the bottom of chamber 38 and that the discharge port 48 serves this sump.

The housings 50 and 51 are concentric to each other and are U-shaped in transverse section, as shown in Figures 1 and 2. The outer vertical walls of housings 50 and 51 extend above the inner walls thereof, and both outer walls are provided with angularly, inwardly and upwardly extending covers 156 and 158. In this connection it will be observed that the cover 156 projects radially outwardly beyond the inner housing 51 and that the projecting eave portion thereof projects over the inner wall of the outer housing 50 to seal the same. Also, it will be readily apparent from the drawings that the inlets 56 and 58 of chambers 52 and 54 are formed by merely extending the outer wall of each housing 50 and 51 above the inner wall thereof.

The wash-water housing 51 is raised to bring inlet 58 into register with outlet port 48 by a series of levers 164 which are fulcrummed to the frame 22 and preferably are operated by a hydraulic cylinder 160 (Figure 10).

The crystal chamber 31 is formed by an annular sheet-metal housing 166 having an outer substantially vertical wall 168 provided at the upper edge thereof with an inwardly extending annular flange 170 which terminates adjacent to and just below the periphery of curb ring 36. Housing 166 is stationary and is secured in any suitable manner to the frame 22. The bottom of housing 166 is supported from the side wall 168 and comprises an annular plate 172 having a short upstanding, circular wall 174 at the inner edge thereof and adjacent the outer wall 142 of liquor chamber 38. Plate 172 is supported for rotation by sets of vertical and horizontal rollers 176 and 178 (Figure 3). Each set of rollers is carried by a supporting bracket 180 which is fastened to and depends from the outer vertical wall 168 of housing 166. Below and fixed to the plate 172 is a pulley 182 which is rotatably driven by a motor 184 through endless belts 186. Motor 184 rotates the plate 172 relatively slowly. Sugar crysals discharged into chamber 31 from basket 20 fall on to the rotating bottom plate 172 and are pushed off the plate into discharge spout 32 by a plow or baffle 188 which is carried by and projects radially, angularly inwardly from the wall 168 across the plate 172 (Figure 2).

Any syrup or wash water which may drip on to the curb ring 36 or any crystals or syrup from the basket 20 which may overflow the curb ring are thrown by centrifugal force into a housing or overflow chamber 190 which surrounds the upper part of the crystal housing 166. The housing 190 comprises a vertical circular wall 192 arranged concentrically to and spaced circumferentially from the wall 168 so that the latter wall, in effect, partitions the overflow chamber from the

crystal chamber 31. At the lower edge thereof, the wall 192 is formed with an inturned flange 194 which is secured to the wall 168, and at the upper edge thereof the wall 192 supports a cover 196 having a central opening 198 through which the drive shaft 26, syrup supply pipe 34, and wash pipe 46 extend. At the bottom of housing 190 is a discharge pipe 200 which conducts any material thrown into the housing back into the process.

For a detailed description of the wash pipe 64 and fluid motor 72, attention is directed to Figure 7. It will be observed that fluid motor 72 comprises a cylinder 202 and a piston 204 mounted for reciprocation in the cylinder. The lower end of cylinder 202 is closed by a plate 206 and the upper end thereof is closed by a plug 208. Wash pipe 64 extends through and is slidably supported by the plug 208, and the end thereof within the cylinder 202 is fixed to the piston 204. A stuffing box 210 carried by the plug 208 provides a fluid tight seal with the pipe 64. The piston 204 has a central aperture 212 which opens through the side thereof and communicates with the spray pipe 64. A gauge tube 214 is welded or otherwise fixed on the upper face of the piston 204 and abuts against the closure plug 208 to limit upward movement of the piston 204 in the cylinder 202.

Hydraulic fluid is delivered to the cylinder 202 below piston 204 through a pipe 216 connected to the plate 206. Also, hydraulic fluid may be supplied to the cylinder 202 above the piston 204 through a pipe 218 which opens through the side of the cylinder immediately below the upper closure plug 208. When the piston 204 is at the upper limit of its travel, aperture 212 communicates with a pipe 220 which is screwed into the side wall of cylinder 202; and the pipe 220 is connected to a second pipe 222 through a check valve 224 which permits liquid to flow from pipe 222 to pipe 220 but prevents reverse flow therethrough. Pipe 222 also is screwed into the side wall of cylinder 202 and is located immediately below the piston 204 when the latter is fully raised as shown in the drawing.

As suggested, the wash pipe 64 normally is lowered so as not to obstruct vertical travel of the basket 20. Therefore, in use, the first operation is to admit hydraulic fluid into the cylinder 202 through pipe 216 to raise the piston 204 to the position shown in Figure 7 and to position the discharge end of wash pipe 64 in proximity to the basket 20. Hydraulic fluid admitted into the cylinder 202 below piston 204 causes the latter to rise until it is stopped by the gauge tube 214. When the piston 204 reaches the upper limit of its travel, it establishes communication between the cylinder 202 below the piston 204 and pipe 222. Hydraulic fluid then flows through pipe 222, valve 224 and pipe 220 to the central aperture 212 and thence passes upwardly through wash pipe 64 which discharges it against the bottom of the housing in the manner hereinabove described. After the washing operation is completed, flow through pipe 216 is stopped and hydraulic fluid is admitted into the cylinder 202 above piston 204 through pipe 218. When piston 204 moves downwardly sufficiently to establish communication between the cylinder above the piston and pipe 220, check valve 224 automatically closes to prevent fluid from entering the central aperture 212 and locking the piston.

An alternative structure for supporting the curb ring 36 is shown in Figure 9. In the modified form of the invention, the supporting rods 42 are operated in unison by fluid motors 226 to raise and lower the curb ring 36. As shown in the drawings, the rods 42 extend axially into the motor cylinders 228 through stuffing boxes 230 and are fastened to piston 232 which operate in the cylinders. Cylinders 228 conveniently may be fastened to the bottom of the liquor housing 142.

Hydraulic liquid is supplied to the cylinders 228 alternately through pipes 234 and 236, and the operation is timed so that the pistons 232 are raised sufficiently to lift the curb ring 36 from the basket 20 as shown in Figure 6 just before the basket is lowered. In operation, the curb ring 36 may be returned to its closed position either before or after the basket 20 is raised to its charging position.

Reference is now had to Figure 10 which shows the hydraulic and fresh water circuits for the separator as well as the electrical network for operating the various parts of the separator automatically and in proper sequence.

A pump 240 driven by motor 242 draws hydraulic liquid from a tank 244 through an inlet pipe 246 and discharged the same through an outlet pipe 248, which outlet pipe supplies liquid under pressure to various fluid motors which operate the movable parts of the separator.

In this connection, it will be observed that the charging valve 35 is operated by a fluid motor 250 and that the latter is controlled by a solenoid operated reversing valve 252. In the drawing, valve 252 is shown positioned to retract the piston in fluid motor 250 whereby to close the charging valve 35. However, it will be readily apparent that if valve 252 is

moved to the right, as viewed in the drawing, hydraulic liquid from line 248 will advance the piston in fluid motor 250 and open the charging valve 35. Hydraulic liquid forced from fluid motor 250 during operation of the same passes through reversing valve 252 and is conducted to a pipe 254 through either of pipes 256 or 258 depending on the position of the valve. Pipe 254 returns the liquid to tank 244.

To operate the wash water housing 51, hydraulic liquid under pressure passes from the supply pipe 248 through pipe 260 to a solenoid operated reversing valve 262 and thence flows through one of pipes 264 or 266 to the fluid motor 160. Manifestly, actuation of motor 160 causes fluid to be returned to valve 262 through the other of pipes 264 and 266 and this liquid flows to the return line 254 through a pipe 272.

In connection with the operation of basket 20, hydraulic liquid is conducted from the supply pipe 248 to the valve 122 through pipe 274. Communication is established between the valve 122 and the motor 30 which operates the basket in the manner hereinabove described, and liquid discharged from valve 122 is carried by one or the other of branch pipes 276 and 278 to a return pipe 280 which in turn is connected to the main return pipe 254.

In order that pump 240 and motor 242 may idle and use comparatively little power during off-cycle periods or during the interval between operations of the separator, the hydraulic circuit is provided with a by-pass 282 which conducts hydraulic fluid from the pressure side of the pump 240 back to the tank 244 through a pressure relief valve 284. The pressure relief valve here shown is of the balance piston type and is controlled by a solenoid operated valve 286, which valve 286 in turn controls flow of hydraulic liquid through a second by-pass 288 between the main return pipe 254 and the relief valve 284 in the conventional manner.

Fresh water is supplied to the rinse and wash pipes 46 and 64, respectively, from a suitable source of supply here indicated as a tank 290. Specifically, a pump 292 driven by a motor 294 draws water from the tank 290 through inlet pipe 296 and discharges the same through an outlet pipe 298 which connects with branch pipes 200 and 302. Branch pipe 300 leads to a solenoid operated reversing valve 304 which controls pipes 306 and 308 leading to the fluid motor 72 which actuates the wash pipe 64. Return liquid from the fluid motor 72 passes through the reversing valve 304 and thence through pipe 310 back to the tank 290. The other branch pipe 302 is controlled by a solenoid operated valve 312 and leads directly to the wash pipe 46.

A plurality of normally open mercury-type switches S1, S2, S3, S4, S5 and S6 are closed in predetermined sequence by cams 314, 316, 318, 320, 322 and 324 to operate the various mechanisms of the separator in properly timed, sequential relation, and a timer motor 326 rotates the cams 314—324 in unison and at proper speed. Current is supplied to the various circuits of the electrical network through power busses 328 and 330.

A conductor 332 connects the motor 326 across the busses 328 and 330, and a manually operable switch 334 controls flow through the conductor. When the switch 334 is closed, current traversing conductor 332 energizes motor 326 to start cams 314—324 rotating. A by-pass conductor 336 around motor 326 is equipped with a pilot light 338, which light may be mounted in any readily visible position on the separator or its control panel and indicates when the motor 326 is energized.

As soon as the first switch S1 is closed by cam 314, a circuit is closed through a control relay CR1, which relay is connected across the power busses 328 and 330 and in series with the switch S1 by conductors 340, 342, 344 and 346. Relay CR1 operates two normaly open switches SW7 and SW8 and a normally closed switch SW9. Switch SW7 controls a conductor 348 which connects an auxiliary timing device 350 across the power busses 328 and 330. The normally closed switch SW9 also controls the conductor 332 and thus the operation of the motor 326. The purpose of switch SW8 will be hereinafter described in detail. When relay CR1 is energized, it closes switch SW7 and opens switch SW9. This drops out the motor 326 to stop rotation of cams 314—324 and cuts in the auxiliary timer 350 which controls the circuit for a predetermined period of time and then mechanically reverses the switches SW7, SW8 and SW9 in an obvious manner by means of an arm 351 to again start the motor 326 in operation.

Normally open switch SW8 controls a conductor 352 which connects solenoid V1 across the power busses 328 and 330 and the solenoid V1 operates the reversing valve 252 which controls the charging valve 35. When switch SW8 is closed by energization of relay CR1, the solenoid V1 is energized to operate reversing valve 252 and to open the charging valve 35. Syrup is then charged to the basket 20 continuously until the auxiliary timer

350 completes its cycle of operation and returns he switch to its normal open position. Thus the basket 20 receives a predetermined charge of syrup and crystals for each operation of the valve 35 and the cycle is timed so that the basket is substantially fully charged during each operation of the valve.

As a safety feature to prevent overcharging of the basket 20 due to changes in viscosity of the charged material or other factors, the basket is equipped with a float valve S10 which controls a relay CR2 connected across the power busses 328 and 330 by a conductor 354. Relay CR2 operates a normally closed switch SW11 in conductor 352 and a normally open switch SW12 in a conductor 356 which joins conductors 352 and 354. If the liquid level in the basket 20 rises sufficiently to operate the float valve S10 before the auxiliary timer 350 closes the charging valve 35, relay CR2 is energized, switch SW11 is opened and switch SW12 is closed. As soon as switch SW11 opens, the circuit through solenoid V1 is broken and the reversing valve 252 is actuated to close the charging valve 35. Simultaneously switch SW12 closes a holding circuit which maintains relay CR2 energized even though the liquid level in basket 20 drops sufficiently to open the float valve S10 and until the auxiliary timer 350 completes its cycle of operation to return switches SW7, SW8 and SW9 to their normal positions. Manifestly, when switch SW8 is opened by the auxiliary timer 350 the holding circuit through relay CR2 is broken and switches SW11 and SW12 return to their normal positions preparatory to the next operating cycle.

When the timer motor 326 is energized by closure of switch SW9, cams 314—324 again begin to rotate. A short drainage period is provided after the charging operation to permit the syrup to be centrifuged from the housing and cam 316 then closes switch S2 to complete a circuit through the solenoid V2 which is connected across the main busses 328 and 330 by a conductor 358. Solenoid V2 operates the reversing valve 262 which directs fluid to the motor 160 to raise the wash water housing 51.

Shortly after switch S2 is closed cam 322 closes switch S5 to complete a circuit through solenoid V5 which is connected across the main busses 328 and 330 by a conductor 360. Solenoid V5 opens valve 312 so that water is charged to the spray pipe 46 to wash the crystals collected in basket 20. After a suitable interval, switch S5 is released by cam 322 to shut off the wash spray and the timer motor 326 then allows a short period for drainage.

At approximately the time the wash spray shuts off, cam 324 closes switch S6 to complete a circuit through solenoid V6 which is connected across the main busses 328 and 330 and in series with the switch by a conductor 362. Energization of solenoid V6 opens the by-pass valve 286 so that hydraulic fluid flows in a short open circuit. As a result, pressure in the hydraulic circuit drops so that the pump 240 and motor 242 merely idle and consume very little power.

At the end of the drainage period, switch S6 is released by cam 324 to de-energize solenoid V6 and close by-pass valve 286 so that pressure in the hydraulic fluid line returns to normal. At about the same time cam 316 releases switch S2 to de-energize solenoid V2, whereby to lower the wash water housing 51 to its normal position so that the discharge port 48 again registers with the syrup housing 50.

As the next step in the operation cycle, cam 318 closes switch S3 to complete a circuit through solenoid V3 which is connected across the main busses 328 and 330 and in series with the switch by a conductor 364. Energization of solenoid V3 positions the valve 122 so that hydraulic fluid under pressure operates fluid motor 30 to lower basket 20 whereby to discharge crystals from the basket into the crystal housing 166. After discharge of the crystals is completed, cam 318 releases switch S3 to de-energize solenoid V3 whereby to return the valve 122 to its normal position and to raise the basket 20 preparatory to another charging operation.

At about the time the basket 20 is fully raised, cam 314 again closes switch S1 to repeat the cycle of operation described above. This same cycle of charge, wash, drain and discharge may be repeated over and over again entirely automaticaly as long as desired.

As suggested, the apparatus also includes means for operating a wash pipe 64 periodically to flush away syrup and crystals which accumulate in the basket 20 below stripper 28. Since syrup and crystals under the stripper 28 tend to impair the operating efficiency of the separator, it is desirable that the washing operation be performed automatically after the machine has cycled a predetermined number of times. In the apparatus here shown, a selector switch S13 is connected in the circuit, which selector switch controls the wash operation, and is manually adjustable to cause the operation to occur every one to ten cycles of

the machine. In the drawing, the selector switch S13 is set to cause the wash operation to occur during every sixth cycle of the machine.

More specifically, the selector switch S13 has two series of ten contacts each designated generally at A and B, respectively. The contacts in each set are arranged in a generally circular pattern and corresponding contacts in the two sets are electrically connected. Electrically conductive arms 364 and 366 are rotatably mounted to sweep respective sets of contacts A and B. Arm 364 is manually rotatable and can be positioned to engage any contact in the series B. On the other hand, the contact arm 366 is mechanicaly operated by a pawl and ratchet 368 and 370. Pawl 368 is urged against the ratchet 370 by a spring 371 and is actuated by a relay R1 which is connected across the main busses 328 and 330 and in series with switch S1 by a conductor 372. Ratchet 370 rotates against the action of a spring 374, and a slidable stop bar 376 is urged against the ratchet by a spring 378 to prevent spring 374 from returning the ratchet 370 to its initial position after each operation of pawl 368. Also, it will be observed that the stop bar 376 is provided with an upstanding lug 380 which extends upwardly at one side of a laterally projecting pin 382 on pawl 368. This arrangement permits axial movement of pawl 368 to rotate ratchet 370 without disturbing the stop bar 376; however, the stop bar can be retracted to disengage pawl 368 from the ratchet so that spring 374 can return the ratchet to its normal position. According to the present invention, the stop bar 376 is retracted by a bell crank 384 which in turn is actuated by a relay R2.

Thus it will be readily apparent that relay R1 will be energized each time switch S1 is closed, i.e., once during each cycle of the machine, and that the arm 366 will be moved one contact in a counterclockwise direction each time the relay R1 is energized. When arm 366 is moved a sufficient number of times to close a circuit through arm 364, the washing operation is caused to occur. With the arm 366 as shown in the drawing and the arm 364 set to the dotted line position shown, the machine must cycle six times to move arm 366 to the position in which an electrical circuit is completed between arms 364 and 366.

According to the present invention, the switch S13 is connected in the network with arm 366 electrically connected to bus 328 and in series with switch S4 by a conductor 386, and arm 364 is electrically connected to the main bus 330 by a conductor 388. Thus when arms 364 and 366 are positioned to close the circuit, current will flow through switch S13 as soon as cam 320 is rotated to close switch S4. In this connection, it will be readily apparent that switch S4 is closed once during each cycle of the machine but current does not flow through switch S13 until arms 364 and 366 are positioned to close a circuit through the switch.

In order for switch S13 to control the washing operation, a relay CR3 is inserted in conductor 388, which relay has four normally open switches SW14, SW15, SW16 and SW17. Switch SW17 is electrically connected across the main busses 328 and 330 and in series with a solenoid V4 by a conductor 390. Solenoid V4 actuates the reversing valve 304 which controls fluid motor 72 for actuating and charging wash pipe 64.

Thus, relay CR3 is energized whenever switches S4 and S13 are closed and energization of the relay closes contact SW17 to complete a circuit through solenoid V4 to perform the washing operation. In this connection, it is to be understood, of course, that cam 320 is positioned to close switch S4 sometime during the cycle when the basket 20 is raised.

In order to permit the switch S13 to be reset automatically after each washing operation, relay R2 is electrically connected to conductor 388 between switch S13 and relay CR3 by a conductor 392 and to the main bus 330 in series with switch SW16 by a conductor 394. Also, a holding circuit is provided for relay R2 through switch SW15 by a conductor 396. Manifestly, energization of relay CR3 also closes switches SW15 and SW16, and closure of the latter switch energizes relay R2 to retract stop bar 376 and reset switch S13 in the manner hereinabove described. As suggested, closure of switch SW15 completes a holding circuit through relay CR3 so that the latter is not de-energized when spring 374 returns arm 366 to its initial position during the resetting operation.

Normally open switch SW14 is connected across the busses 328 and 330 and in series with solenoid V2 by conductor 398. Thus, solenoid V2 is energized to raise the wash housing 51 each time relay R3 is energized whereby the wash water is collected in the wash housing 51 and does not contaminate syrup in the housing 50.

In order to prevent the washing operation from occurring, through some inadvertence, when the basket 20 is lowered, a relay CR4 is connected in parallel with solenoid V3 by conductor 400. Relay CR4 has a normally closed switch SW18 in

conductor 388 and in series with relay CR3, thus if solenoid V3 is energized for any reason to lower housing 20 when switches S4 and S9 are closed, switch SW18 will be open to break the circuit through relay CR3 and thus prevent a circuit from being completed through solenoid V4 to perform the washing operation.

A washing operation can be performed manually at any time by means of a normally closed push-button switch S19 which is electrically connected in conductor 388 and in series with switches S4 and S13 and relay CR3. Also, switch S19 is adapted to close a circuit through a conductor 402 which is connected to bus 328 and to conductor 388 between switch S13 and relay CR3. Thus, manipulation of switch S19 by-passes switch S4 and closes a circuit through relay CR3 to perform the washing operation. Switch S19 is normally positioned as shown in the drawing by spring 404. Consequently, it must be held depressed until the washing operation is completed. As soon as the switch S19 is released, it is returned to its normal position by spring 404 to de-energize relay CR3.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A centrifuging apparatus comprising a rotatable and reciprocable basket having a foraminous annular side wall; means for charging said basket with material to be filtered; an axially fixed stripper member snugly fitting within and rotatable with said basket; and actuator means for reciprocating said basket on said stripper.

2. A centrifuging apparatus as claimed in Claim 1, having a curb ring surmounting said basket; and means for holding said curb ring axially fixed and for rotatably driving said curb ring in unison with the basket.

3. A centrifuging apparatus as claimed in Claim 2, wherein the curb ring is positioned to seat downwardly on the rim of the basket, said curb ring being formed with a radially outwardly facing annular shoulder arranged to project into the basket and co-operative with the side wall of the latter to define a pocket within and immediately below the rim of the basket; and means for draining liquid from said pocket.

4. A centrifuging apparatus as claimed in Claim 3, wherein said last-mentioned means offers substantially less resistance to passage of liquid than the joint between said shoulder and the cooperating side wall.

5. A centrifuging apparatus as claimed in Claim 3, wherein the basket is formed at the rim with an inturned annular flange with which the annular shoulder on the curb ring snugly fits, said pocket being formed by a projecting portion of said shoulder and the side wall of the basket.

6. A centrifuging apparatus as claimed in Claim 2, wherein the curb ring projects radially outward from the rim of the basket, and means for rotating the curb ring in unison with the basket disposed exteriorly of the basket and including supports carried by the said radially outward projection.

7. A centrifuging apparatus as claimed in any of Claims 1 to 6, wherein a casing surrounds and rotates with the basket and forms with the walls an annular collecting chamber for material centrifuged from the basket, said chamber having a discharge port adjacent the bottom thereof, annular housings surrounding the casing, each housing having an annular chamber and an annular inlet communicating with said chamber and arranged in confronting relation to the discharge port, and means whereby said inlets may be selectively registered with the discharge port.

8. A centrifuging apparatus as claimed in Claim 7, wherein one of said housings is stationary with its inlet in register with the discharge port and the other of said housings is movable vertically to bring its inlet into register with said port and to close the inlet of the stationary housing.

9. A centrifuging apparatus as claimed in Claim 8, wherein the stationary housing forms a syrup housing and the vertically movable housing forms a wash housing.

10. A centrifuging apparatus as claimed in any of Claims 2 to 8, wherein an overflow housing surrounds the basket and is provided with an inner annular wall having a radially inwardly extending flange in alignment with and spaced circumferentialy from the rim of the curb ring, the housing having an annular inlet above said flange whereby overflow from the basket or material charged to the basket and falling on the curb ring is thrown radially outward by centrifugal force from the curb ring and into said housing, the inner annular wall forming an inner chamber, the stripper being operable to spill solid material over the rim of the basket and into the inner chamber.

11. A centrifuging apparatus as claimed in Claim 1, having a curb ring surmounting said basket and seating

downwardly against the rim thereof, a plurality of fluid actuated means each having a movable wall, and means disposed exteriorly of the basket connecting said movable walls to said curb ring, whereby operation of said fluid actuated means effects independent relative movement between the basket and said curb ring.

12. A centrifuging apparatus as claimed in any of the preceding claims, wherein means are provided for periodically washing the space between the stripper and the bottom of the basket.

13. A centrifuging apparatus as claimed in Claim 12, wherein said means includes a wash pipe arranged to impinge a stream of water upwardly against the bottom of the basket, and means associated with said bottom for collecting the water impinged thereagainst and for discharging it into the space between the bottom and the stripper.

14. A centrifuging apparatus as claimed in Claim 13, wherein the bottom of the basket is provided with an annular groove positioned to receive the stream of water and a plurality of passages effecting communication between the groove and the space between the bottom and the stripper.

15. A centrifuging apparatus as claimed in Claim 14, wherein the groove has an outwardly and upwardly inclined outer wall portion.

16. A centrifuging apparatus as claimed in Claim 13, 14 or 15, wherein the wash pipe is carried by a fluid motor which holds the wash pipe normally lowered so as not to interfere with reciprocation of the basket but adapted to raise the pipe to position the discharge outlet thereof in proximity to the bottom of the basket.

17. A centrifuging apparatus as claimed in any of the preceding claims 12 to 16, having valve controlled means for feeding material to be centrifuged to the basket, valve controlled means for introducing a rinsing liquid into the basket, valve controlled means for the wash pipe, means for rotating the basket and stripper in unison, means for moving the basket and stripper axially relatively to each other, means for operating said valve controlled feeding means, said valve controlled rinsing means and said means for effecting relative axial movement between the basket and stripper acting sequentially and in timed relation, and means for operating said washing means automatically after said last-mentioned means has operated a predetermined number of times.

18. A centrifuging apparatus substantially as described with reference to the accompanying drawings.

Dated this 23rd day of July, 1948.

MARKS & CLERK.

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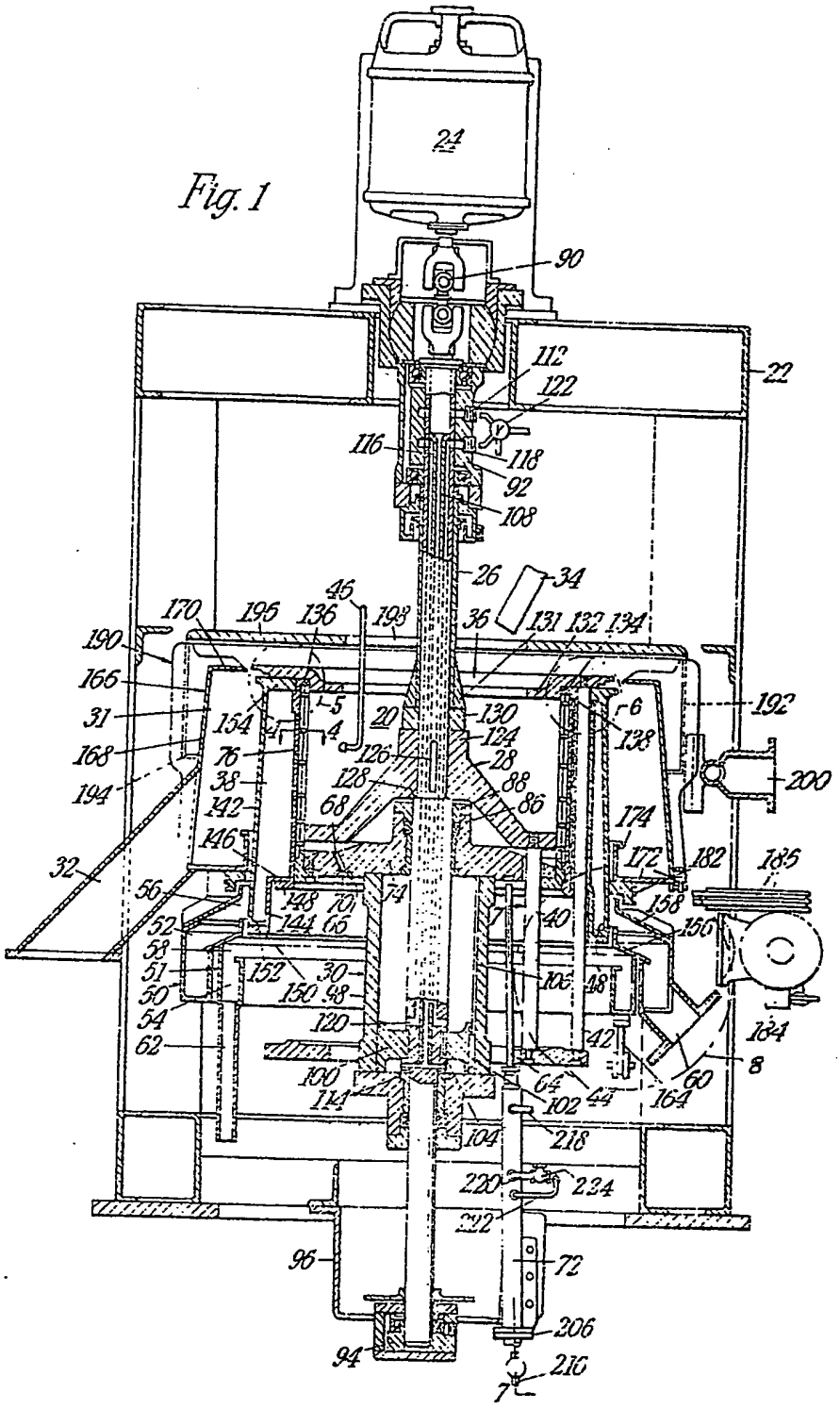
653,126 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1

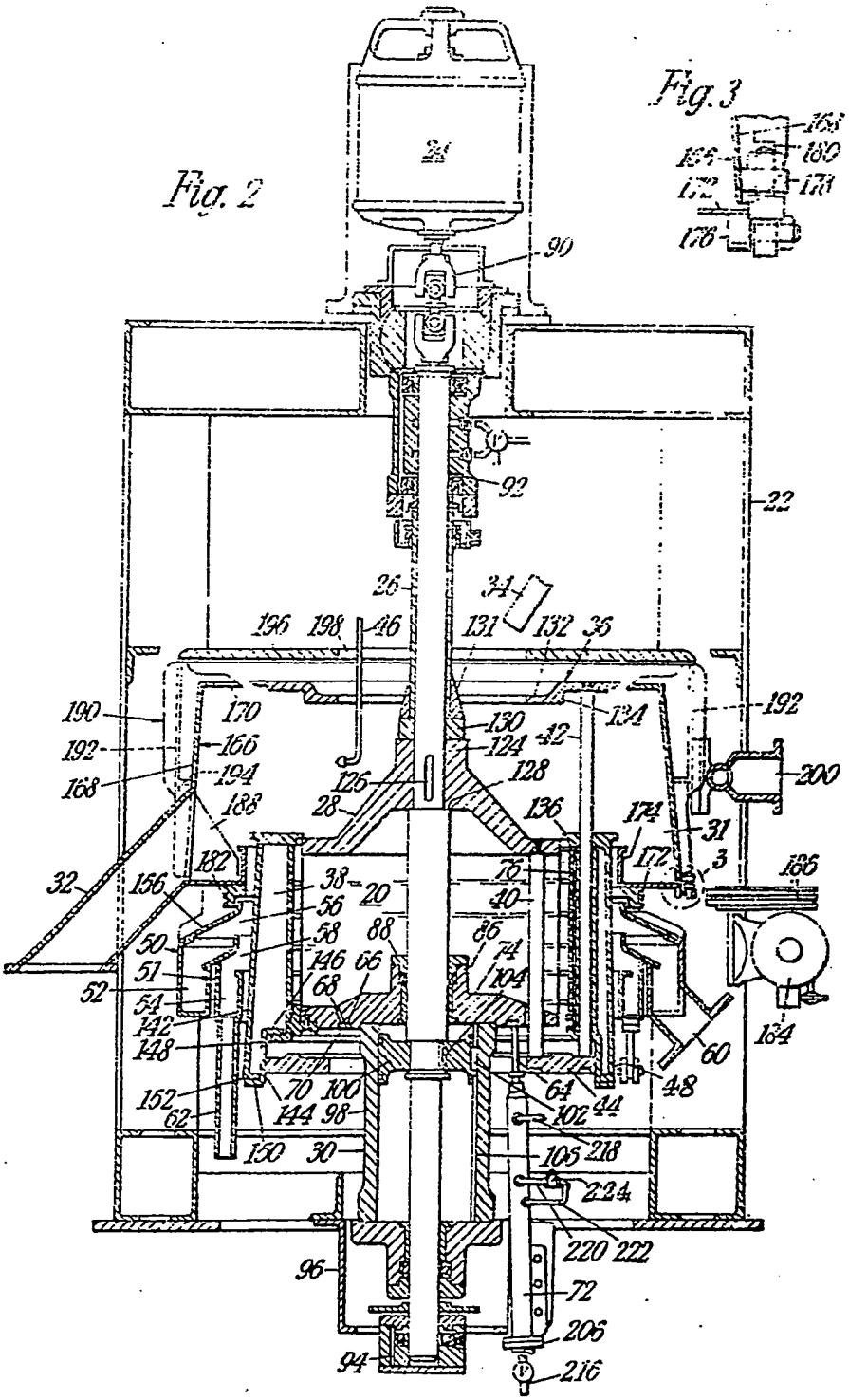


4 SHEETS

SHEET 1

SHEET 2

Fig. 2



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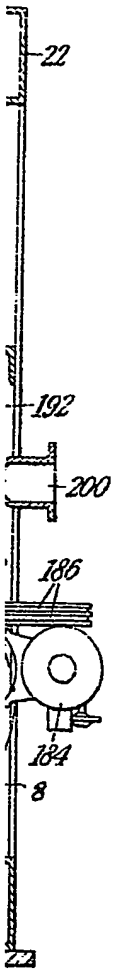
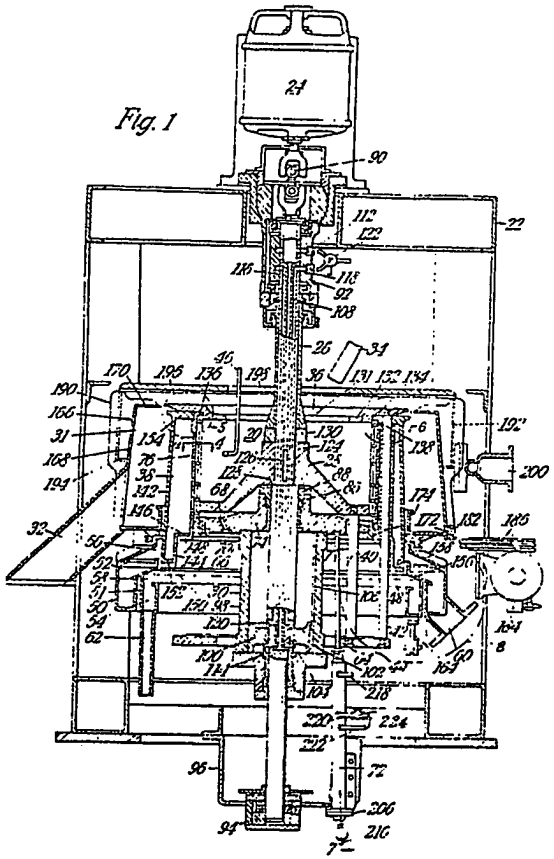


HMSO(T.P)

Fig. 1



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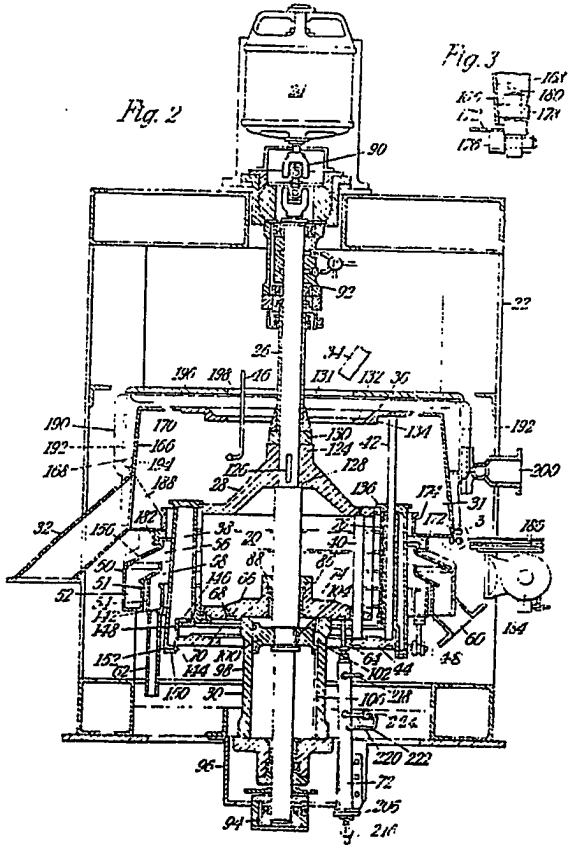
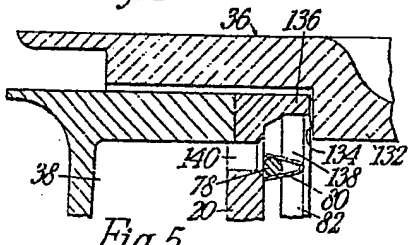


Fig. 3

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 4



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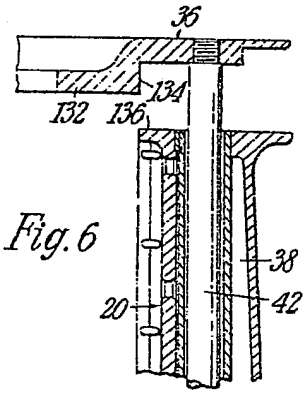

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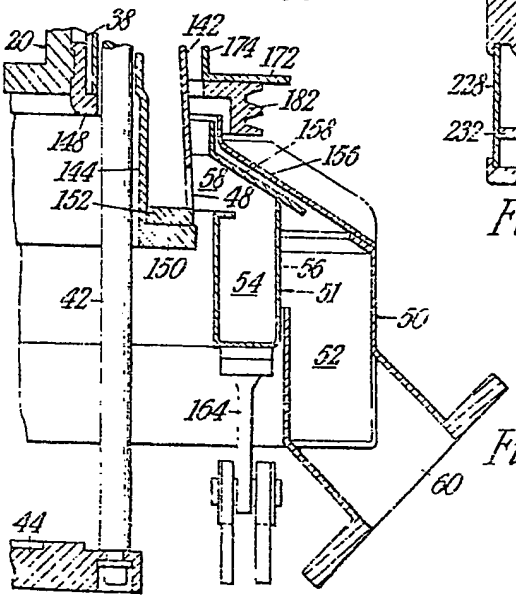
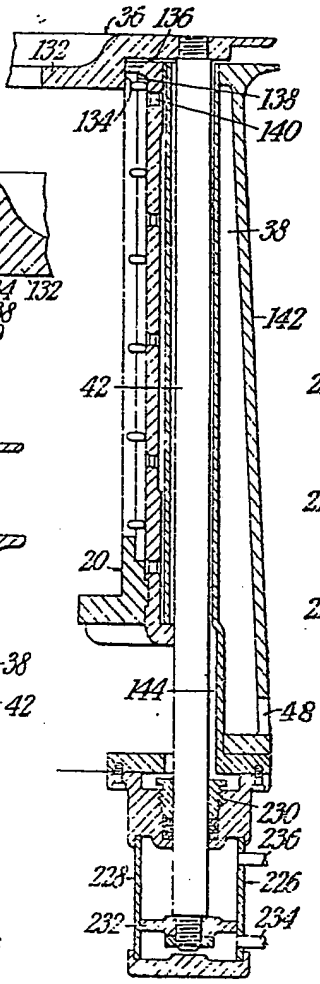


Fig. 8



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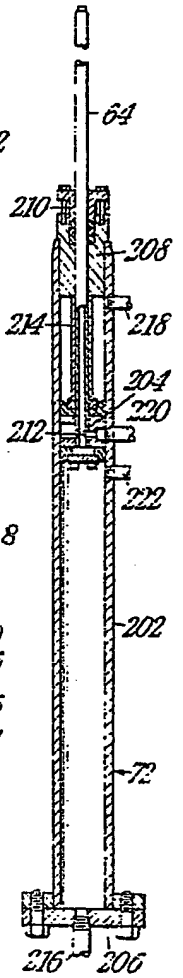

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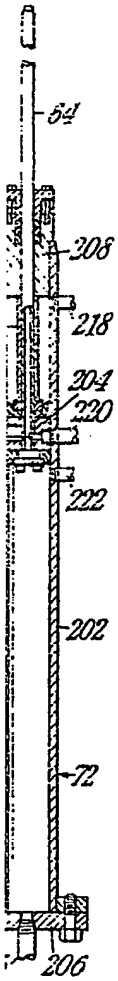
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Fig. 7

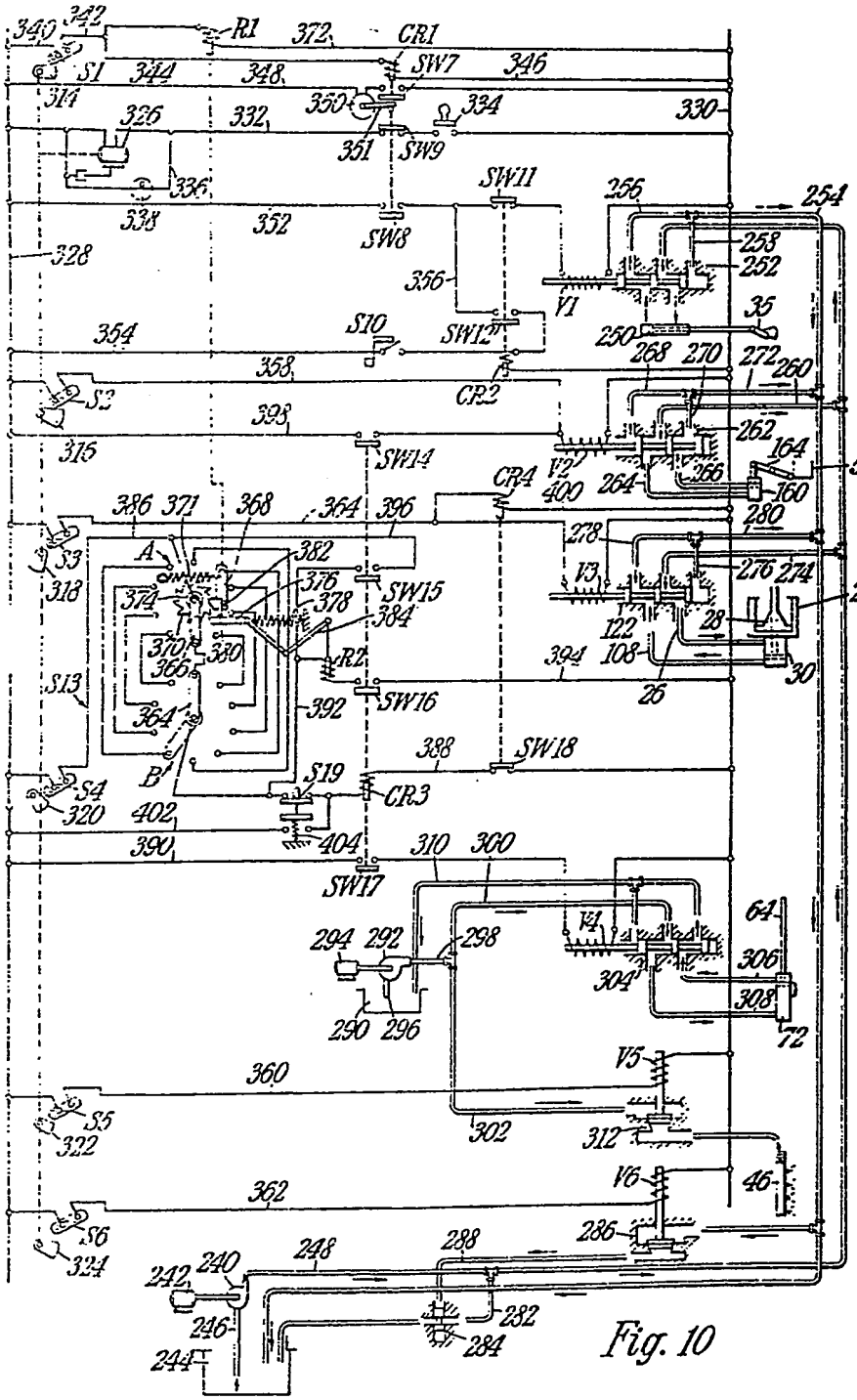
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Fig. 10

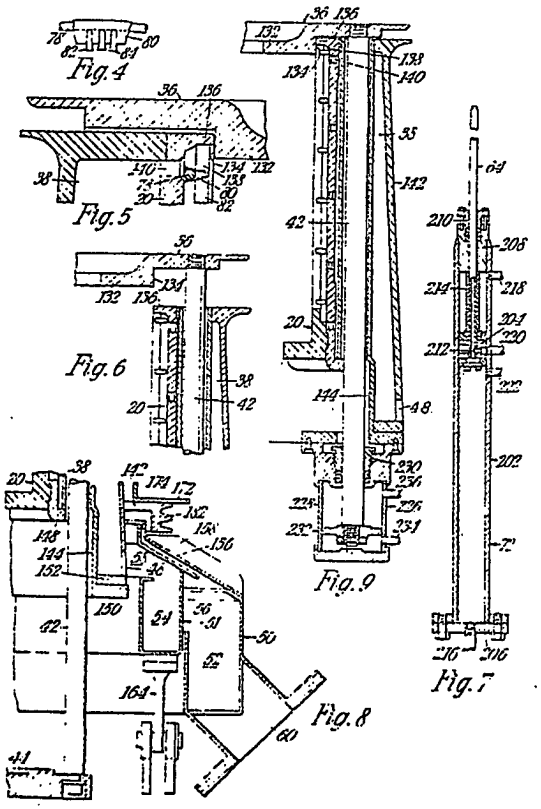

Fig. 4

Fig. 5

Fig. 6

Fig. 8

Fig. 9

Fig. 7

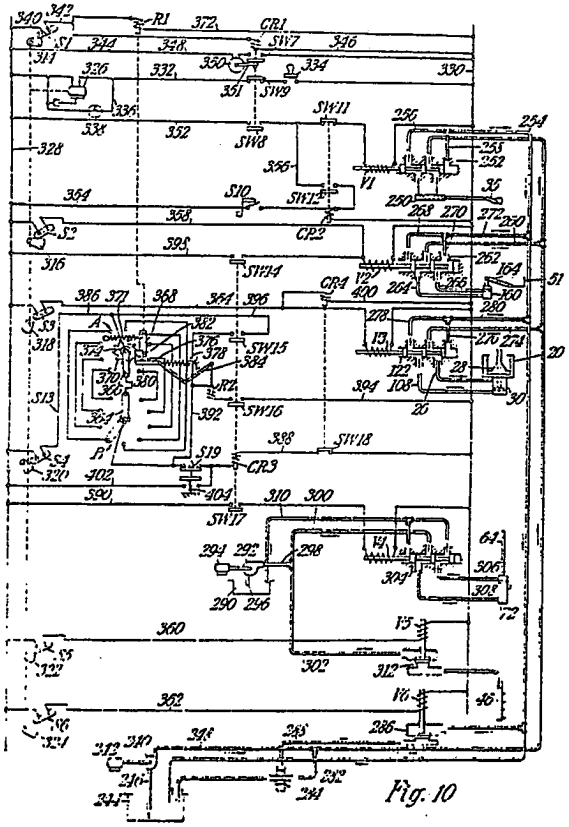

Fig. 10